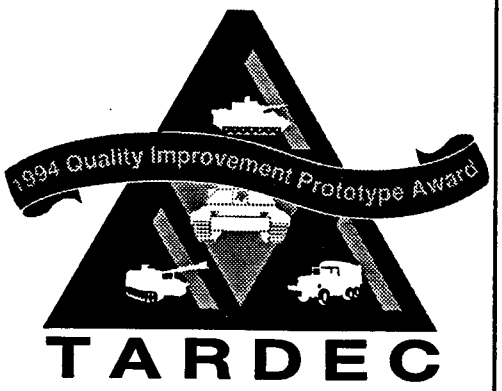
TARDEC

---TECHNICAL REPORT---

THE NATION'S ARMY FOR ADVANCED AUTOMOTIVE TECHNOLOGY

WINNER OF THE 1994 FEDERAL QUALITY IMPROVEMENT PROTOTYPE AWARD

No. 13660



RIDE MOTION SIMULATOR (RMS) TESTING
USING HUMAN OCCUPANTS
(Submitted to Human Use Committee)
FINAL REPORT

DECEMBER 1994

AnnMarie Berger
U.S. Army Tank-automotive and Armaments Command
By Warren, MI 48397-5000

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

U.S. Army Tank-Automotive Research,
Development, and Engineering Center
Detroit Arsenal
Warren, Michigan 48397-5000

NOTICES

This report is not to be construed as an official Department of the Army position.

Mention of any trade names or manufacturers in this report shall not be construed as an official endorsement of approval of such products or companies by the U.S. Government.

Destroy report when it is no longer needed. Do not return it to the originator.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	December 1994	Final Report 17 Oct - 4 Nov 94

4. TITLE AND SUBTITLE
Ride Motion Simulator (RMS) Testing Using Human Occupants (Submitted to Human Use Committee)

5. FUNDING NUMBERS

6. AUTHOR(S)
AnnMarie Berger

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Tank-automotive and Armaments Command
Research, Development and Engineering Center
ATTN: AMSTA-TR-X
Warren, MI 48397-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
See distribution page

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The objective of this report is to summarize the results of using human occupants in the RMS during the Crewmans Associate Job. This report does not address the subjective data obtained on the helmet mounted displays and controllers preferobility and usability. This report will be submitted to the Human Use Committee and describes the tests conducted.

14. SUBJECT TERMS
Laboratory Test, Helmet Mounted Displays, Vibration, RMS, Controllers, Simulation, Humans

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Limited

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to ***stay within the lines*** to meet ***optical scanning requirements***.

Block 1. Agency Use Only *(Leave blank)*.

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	- Contract	**PR**	- Project
G	- Grant	**TA**	- Task
PE	- Program Element	**WU**	- Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

- **DOD** - See DoDD 5230.24, "Distribution Statements on Technical Documents."
- **DOE** - See authorities.
- **NASA** - See Handbook NHB 2200.2.
- **NTIS** - Leave blank.

Block 12b. Distribution Code.

- **DOD** - Leave blank.
- **DOE** - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.
- **NASA** - Leave blank.
- **NTIS** - Leave blank.

Block 13. Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code *(NTIS only)*.

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

PREFACE

This report discusses the use of human occupants in the Ride Motion Simulator (RMS). Questions regarding ride motion simulation of vehicles using the Ride Motion Simulator are to be referred to the U.S. Army Tank-Automotive Research, Development and Engineering Center, ATTN: Simulation, Test and Reliability Group, AMSTA-TR-X, Warren, MI 48397-5000, Telephone: AUTOVON/DSN 786-6228, Commercial (810) 574-6228, FAX (810) 574-8667.

TABLE OF CONTENTS

1.0 INTRODUCTION

The U.S. Army Tank-automotive and Armaments Command (TACOM) has full safety certification from the U.S. Army Test-Evaluation Command (TECOM) for the Ride Motion Simulator (RMS). This certification allows the use of test subjects in the seat of the RMS during its operation. The Crewmans Associate Job was performed on 17 October - 4 November 1994. Human test subjects were used to test and evaluate using various combinations of two different driving controllers and two different helmet mounted displays (HMD) while under terrain-type and sine wave motion conditions.

Prior to conducting a simulation using test subjects, approval for the test plan was obtained from the Human Use Committee (HUC) and the commander of the Tank-Automotive Research Development and Engineering Center (TARDEC). A Volunteer Agreement Affidavit, form DA 5303-R, is completed for each subject. The test was then conducted and this report, summarizing the test results, is being submitted to the HUC to finalize the test.

2.0 OBJECTIVE

The objective of this report is to summarize the results of using human occupants in the RMS during the Crewmans Associate Job. This report does not address the subjective data obtained on the helmet mounted displays and controllers preferability and usability. This report will be submitted to the Human Use Committee and describes the tests conducted.

3.0 CONCLUSION

The tests were completed without incident to any of the test subjects. The use of human occupants provided invaluable test data since the results of the experiment should provide justification for both near and far-term crewstation design decisions.

4.0 RECOMMENDATIONS

This test again shows that the RMS is safe for human use. The large amount of hardware/software interlocks and numerous safety precautions taken by Physical Simulation Laboratory (PSL) personnel before and during operation, make the simulator very safe. The simulator is an excellent tool for a wide variety of testing including controller/HMD combinations, man/machine interaction, etc.

5.0 DISCUSSION

All test runs are listed below.

10/17/94 - 10/28/94

Test Subjects: Soldiers (5) from Ft. Knox, Kentucky.

Test Protocol: Small periods of sinusoidal motion and simulated terrain motions of a Bradley traversing Perryman1 (@25mph), Perryman2 (@15mph), and Churchville B(@10mph) were performed.

Comments: All tests ran smoothly. Each test run lasted approximately 30 minutes and consisted of 9 different sinusoidal motions and 3 different terrains. The testing period went from 0800 hrs to 1600 hrs, 2 runs for each soldier making it a total of ten runs a day.

10/31/94 - 11/4/94

Test Subjects: Civilians (8) from the Crewmans Associate TEAM (TARDEC).

Test Protocol: Small periods of sinusoidal motion and simulated terrain motions of a Bradley traversing Perryman1 (@25mph), Perryman2 (@15mph), and Churchville B(@10mph) were performed.

Comments: All tests ran smoothly. Each test run lasted approximately 30 minutes. The testing period lasted all day (0800-1400), with each subject only riding a total of 4 times during the entire week.

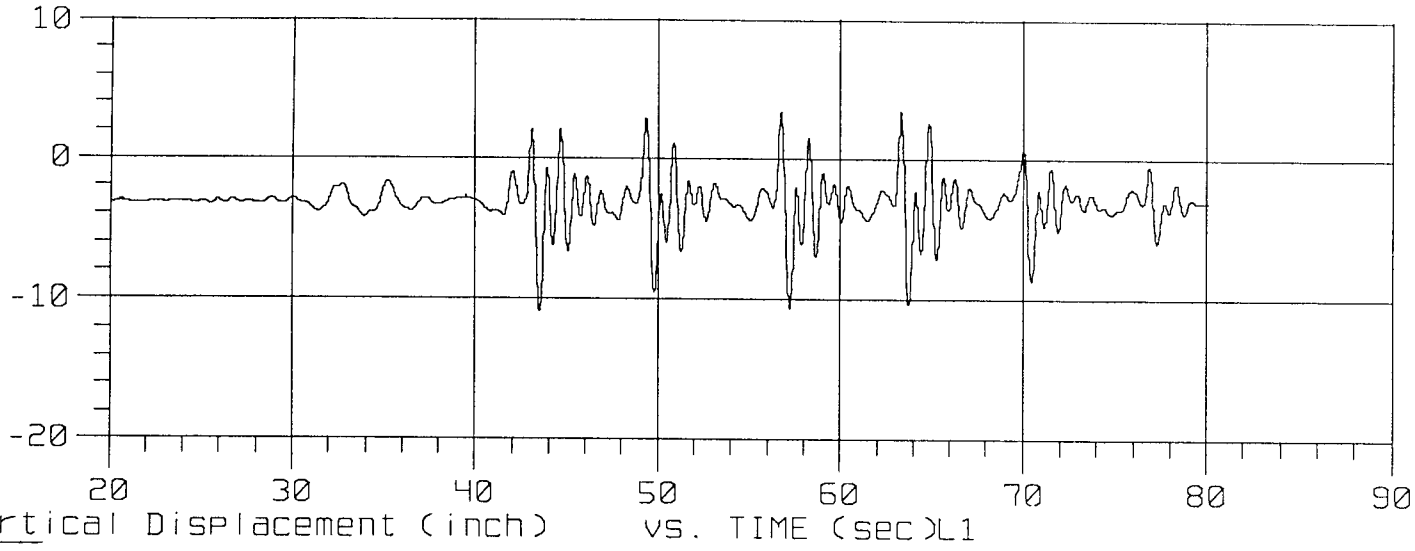
Appendix A contains position and acceleration plots of the dynamic scenarios used. There was a maximum of ± 2 g's of acceleration during the test scenarios as shown in the acceleration plots in the appendix. In summary, no problems were incurred during any of the testing. The test subjects reported no ill effects from the runs.

APPENDIX A

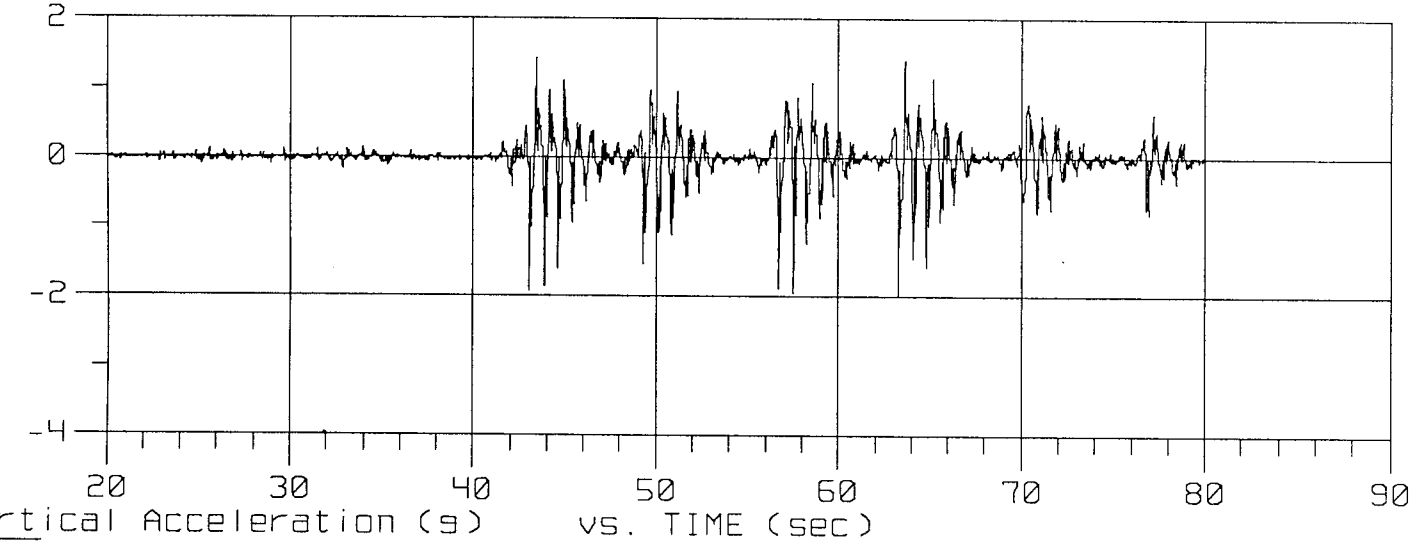
Position and Vertical Acceleration Plots

L1

Measured data for Churchville B @ 10mph

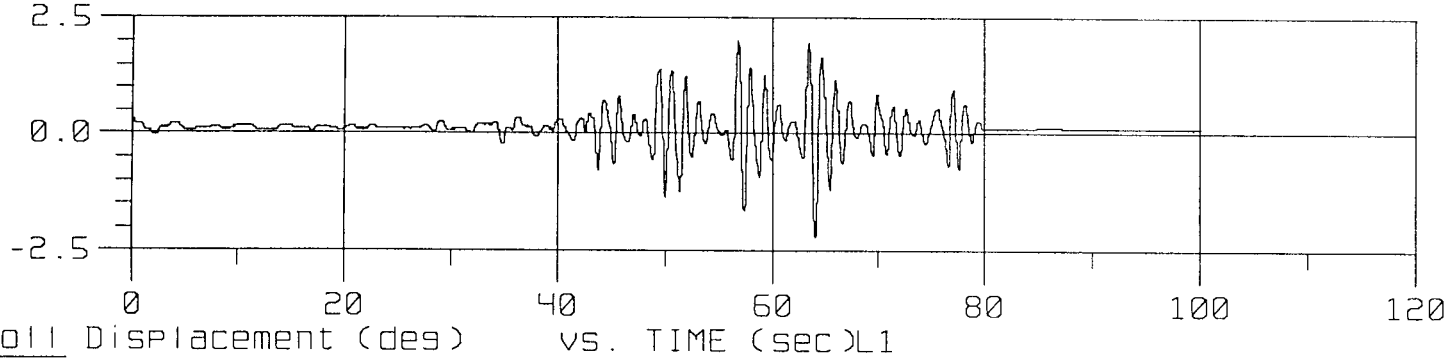


Vertical Displacement (inch) vs. TIME (sec)L1

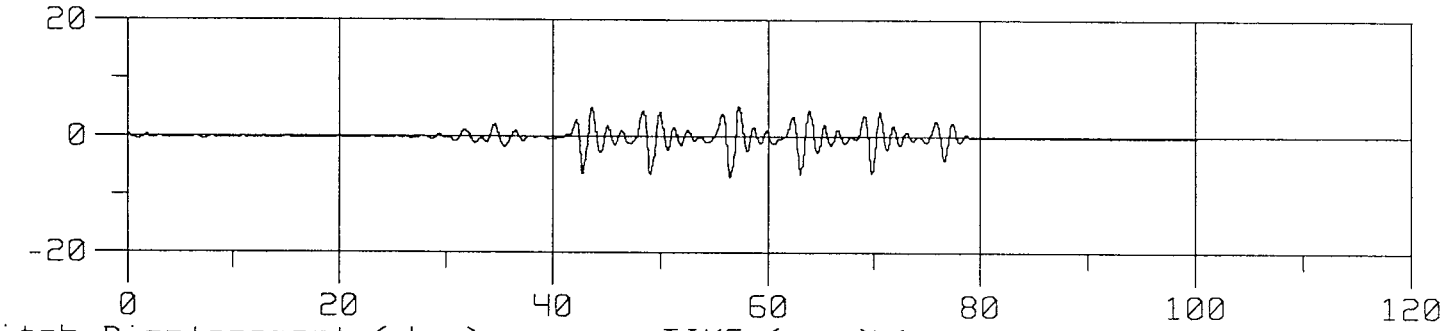


Vertical Acceleration (g) vs. TIME (sec)

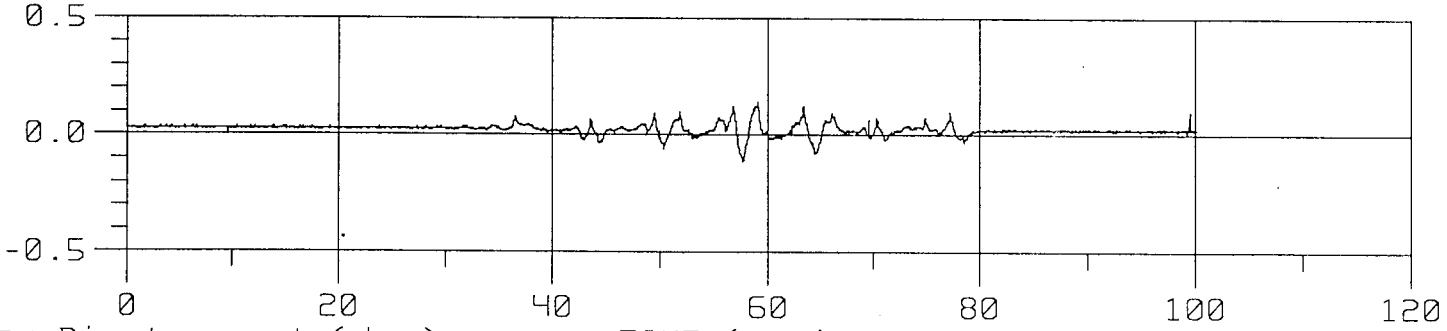
L1 Measured data for Churchville B @ 10mph



Roll Displacement (deg) vs. TIME (sec)L1



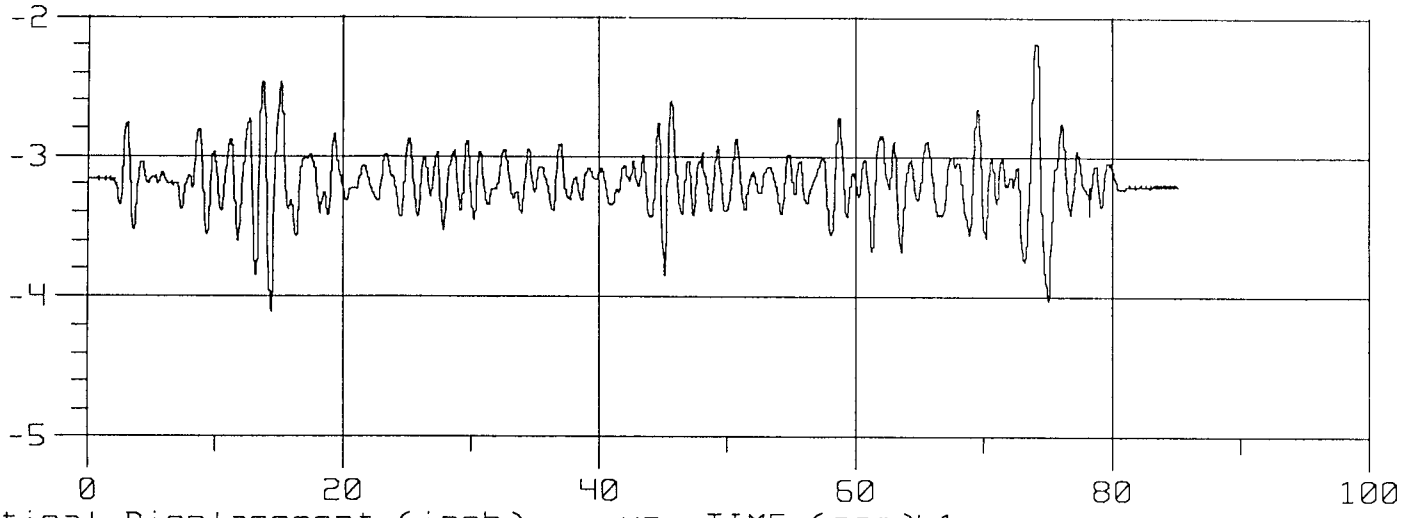
Pitch Displacement (deg) vs. TIME (sec)L1



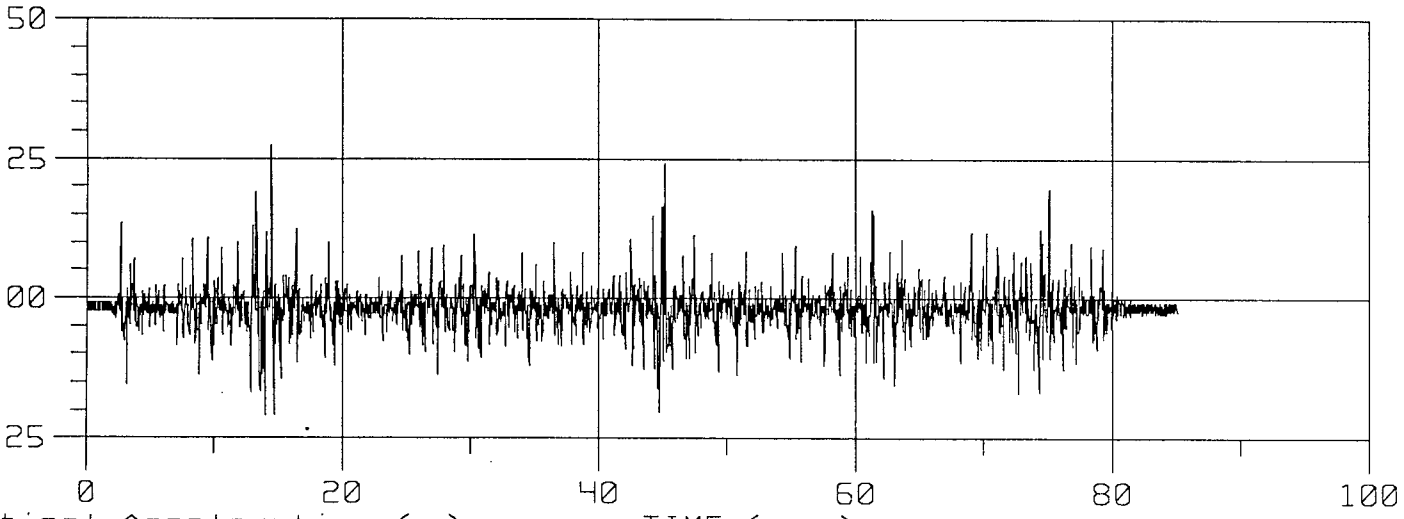
Yaw Displacement (deg) vs. TIME (sec)

L1

Measured Data for Perryman1 @ 25mph



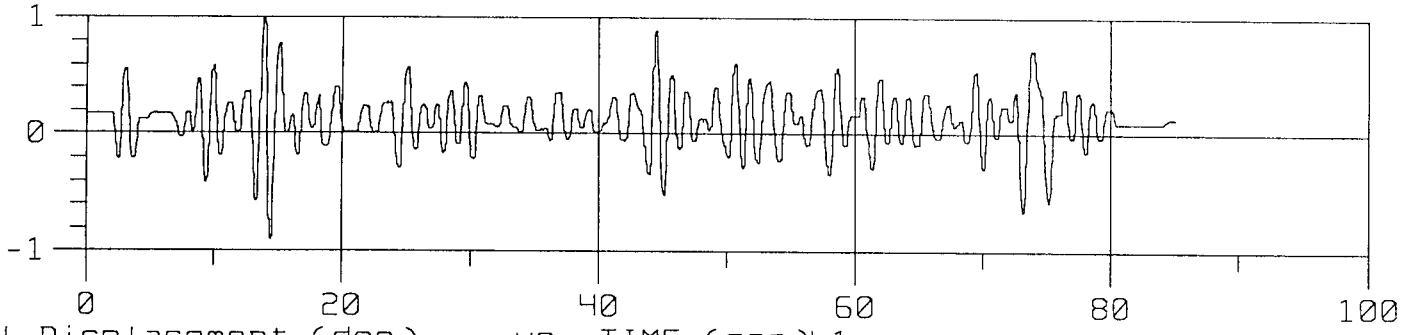
Vertical Displacement (inch) vs. TIME (sec)L1



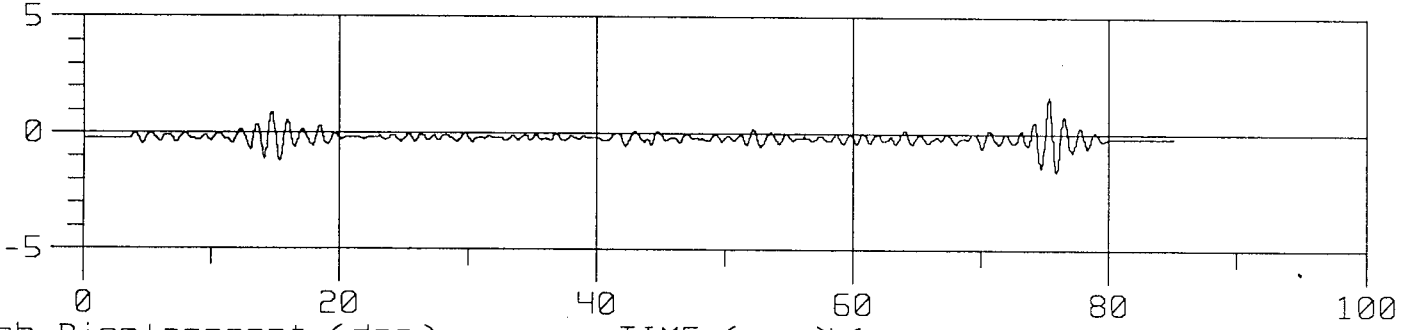
Vertical Acceleration (g) vs. TIME (sec)

L1

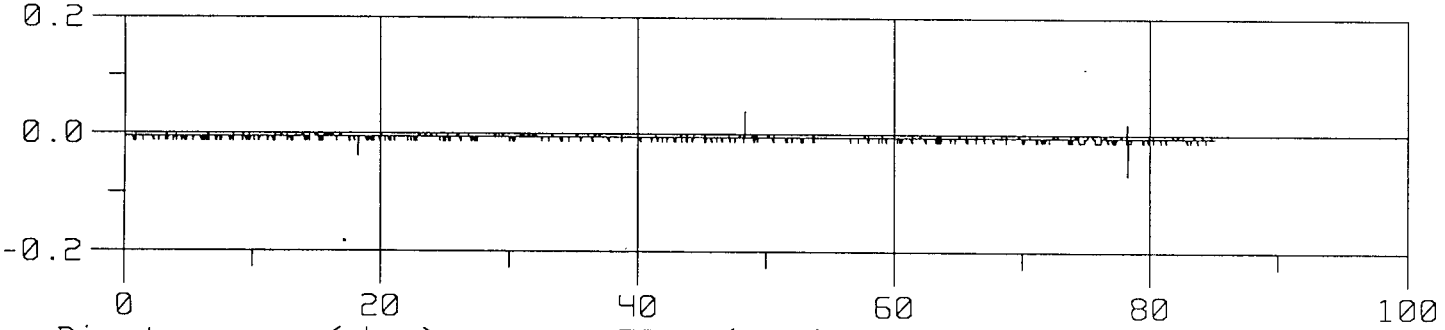
Measured Data for Perryman1 @ 25mph



Roll Displacement (deg) vs. TIME (sec)L1



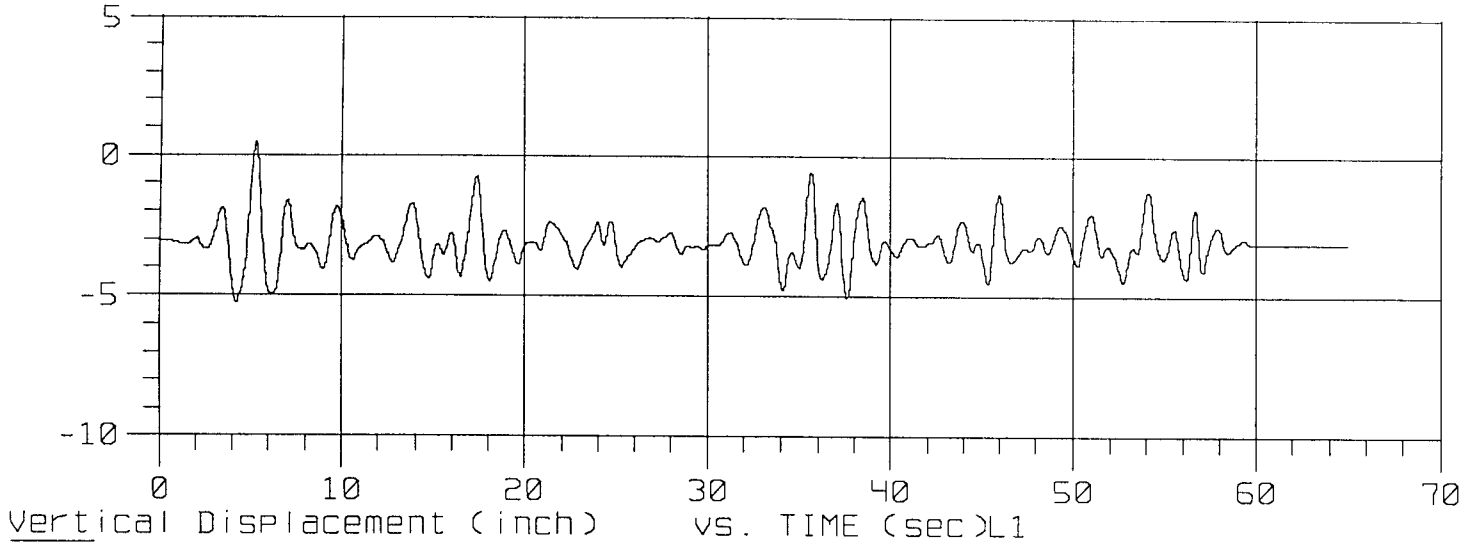
Pitch Displacement (deg) vs. TIME (sec)L1



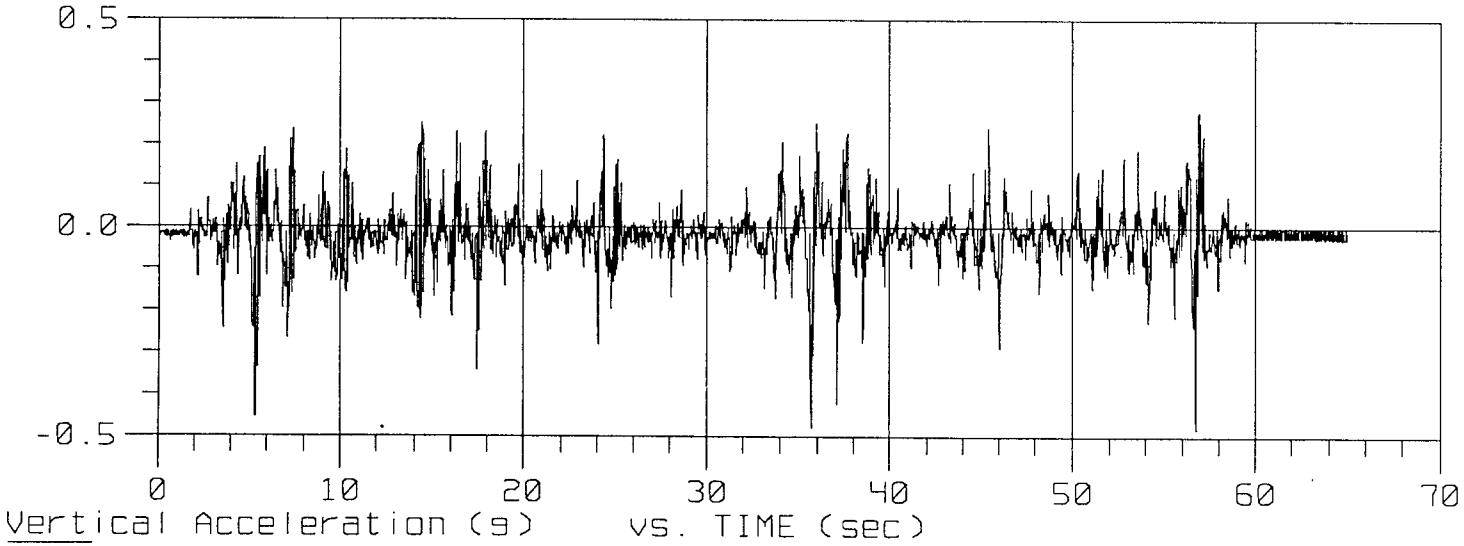
Yaw Displacement (deg) vs. TIME (sec)

L1

Measured Data for Perryman2 @ 15mph



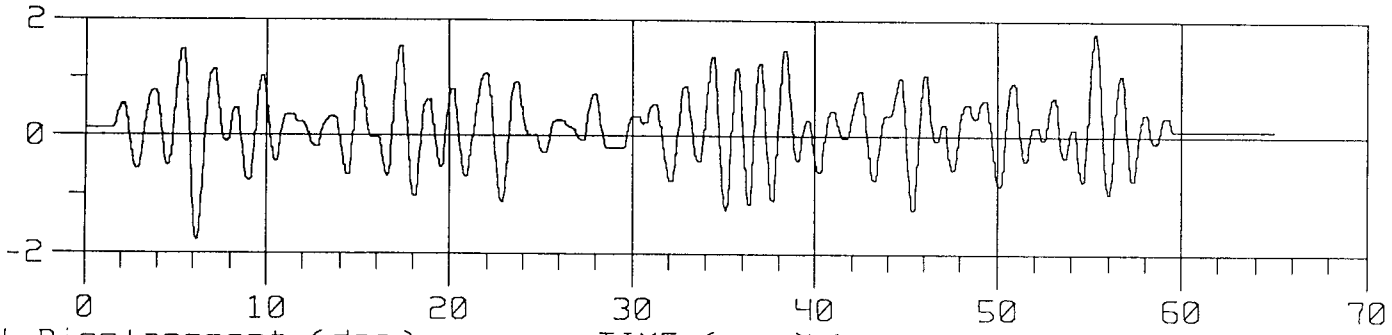
Vertical Displacement (inch) vs. TIME (sec)L1



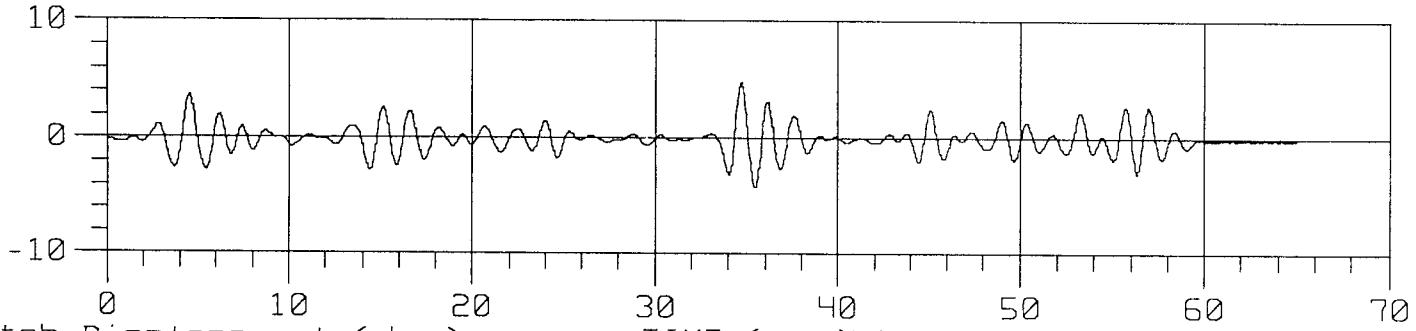
Vertical Acceleration (g) vs. TIME (sec)

L1

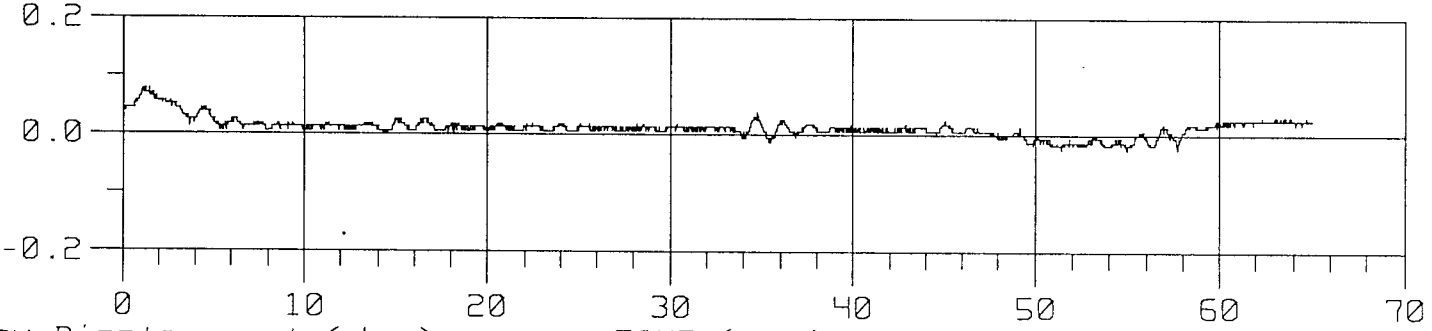
Measured Data for Perryman2 @ 15mph



Roll Displacement (deg) vs. TIME (sec)L1



Pitch Displacement (deg) vs. TIME (sec)L1



Yaw Displacement (deg) vs. TIME (sec)

DISTRIBUTION LIST

Copies

Commander
U.S. Army Tank-automotive and Armaments Command
ATTN: ASQNC-TAC-DIT (Technical Library) 2
AMSTA-TR (Mr. Wheelock) 1
AMSTA-TR-X (Bldg. 215) 4
AMSTA-TR-D (Mr. Culling)
AMSTA-TR-X (Mr. Reid)
Warren, MI 48397-5000

Commander 12
Defense Technical Information Center
Bldg. 5, Cameron Station
ATTN: DDAC
Alexandria, VA 22304-9990

Manager 2
Defense Logistics Studies information Exchange
ATTN: AMXMC-D
Fort Lee, VA 23801-6044

Commander 1
Defense Technical Information Center
Bldg. 5, Cameron Station
ATTN: DDAC
Alexandria, VA 22304-9990

Commander
U.S. Army Material Command
ATTN: AMCDE (development, Eng, & Acquisition) 1
ATTN: AMCDMA-ML (Library) 1
5001 Eisenhower Avenue
Alexandria, VA 22333-0001